SUITABLE TREES FOR THE BOTTOMLANDS OF WEST TENNESSEE[1/]

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Abstract.--Recent abandonment of agricultural bottomlands in West Tennessee has opened many new areas of productive land for intensive hardwood management. This study examined 3 species; sweetgum, green ash, and sycamore; 2 seed sources for sweetgum and sycamore; and 3 cultural treatments; fertilization, disking, and mowing to determine which combination(s) would be best suited to these sites.

After 3 growing seasons, green ash showed a 98 percent survival rate while sweetgum and sycamore both had 93 percent survival. Survival for all 3 species combined was higher in disked plots (97%) than in mowed (92%) or control plots (94%). Fertilization and seed source had no effect on survival.

Height growth for all 3 species was significantly increased by fertilization and disking. The growth of green ash was increased by 25 percent with fertilization while sycamore and sweetgum growth was increased by 19 and 16 percent, respectively. Gains resulting from disking were 52 percent for sycamore, 50 percent for green ash, and 26 percent for sweetgum. Fertilization and disking combined, did not increase height growth over disking alone. Mowing and seed source had no effect on height growth.

Plantations of either sweetgum, green ash, or sycamore would produce stands of greater value than by natural regeneration. However, significant gains in height growth may be achieved by fertilization and even more by disking.

INTRODUCTION

The high economic return generally realized from soybean production over the past decade, has resulted in the clearing of many stands of bottomland hardwoods along the Mississippi River and its tributaries. While this practice has been economically successful on upper terraces, crops have frequently been lost by flooding on first bottoms. Repeated crop losses on these sites have resulted in the abandonment of significant acreages along tributary streams in West Tennessee (Parsons 1982)[3/]. Without management these highly productive sites commonly restock to low value bottomland hardwoods such as boxelder (Acer negundo L.) and river birch (Betula nigra L.).

The availability of these highly productive lands for forestry use provides a unique opportunity to meet the increasing demand for hardwood pulp, fuelwood and logs for veneer and lumber. Their previous use for agriculture makes them readily assessible for cultural treatments to improve survival and growth.

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Although quantitative data on the effects of cultural treatments on the survival and growth of bottomland hardwoods is limited, many forest managers are beginning to intensify their management of these species (Kennedy 1981). Several promising cultural treatments tested to date are fertilization, mowing and disking.

Ammonium nitrate applied at 150 pounds per acre increased the volume growth of a six-year-old cottonwood (Populus deltoides L.) plantation by 200 percent (Blackmon and White 1972). Saucier and Ike (1969) also found that nitrogen fertilization improved the growth of sycamore (Platanus occidentalis L.) and did not have adverse effects on wood properties.

Mowing and disking have been used in intensive hardwood culture primarily to free seedlings from the aggressive herbaceous competition that generally develops on these sites. Kennedy (1981) found that disking increased the height growth of green ash (Fraxinus pennsylvanica Marsh.) by 130 percent while mowing had no significant effect. Survival was also significantly higher in disked plots as compared to either mowed or control plots.

This study was established to evaluate the effectiveness of these three cultural treatments on the survival and growth of selected hardwood species considered to be desirable for plantings on the bottomlands of West Tennessee. As an initial step to this study, sycamore, green ash and sweetgum (Liquidambar styracifula L.) were selected due to their high value on local markets and seedling availability. Other species will be added as seedlings become available.

METHODS

Agricultural lands on the floodplain of a tributary to the Wolf River in Southwest Tennessee were selected for the study. These fields were farmed for soybeans until 1979. Flooding was not an annual problem, however, it occurred often enough that continued cropping was considered risky. Soils were silt loams in which pH ranged from 5.4 to 6.6. Soil tests showed that phosphorus and potassium levels were low for agricultural purposes.

Four replications of a split-plot, randomized complete block design in which five species/seed source combinations (sycamore, green ash, and sweetgum from the Virginia coastal plain and sweetgum and sycamore from the Louisiana Gulf Coast) were tested, with fertilization as the main treatment while disking and mowing were tested at the sub-plot level.

Seedlings were planted in the Spring of 1980. The 5 species/seed sources being tested were represented in each main treatment plot as randomly located sub-plots of 150 seedlings planted in five 30-tree rows on a 10 foot by 10 foot spacing. Since previous studies have shown that fertilization at planting time significantly decreases survival (Buckner and Maki 1977), fertilizer was randomly applied at the beginning of the second growing season to one of the two main-treatment plots in each replication. The three sub-plot treatments (mowing, disking, and control) were randomly applied in each main treatment plot at right angles to the species/seed source plantings.

Fertilization was applied at the rate of 150 pounds of elemental nitrogen per acre and 35 pounds of elemental phosphorus per acre. Specific fertilizers used were ammonium nitrate and triple super phosphate. Disking and mowing were done simultaneously at intervals that would generally keep competing vegetation below 2 to 3 feet in height. This required 5 to 6 mowing/disking operations per year which began in April of the first season following planting and was continued throughout each growing season of the study period.

Survival and tree heights (to nearest 0.5 foot) were measured at the end of the third growing season following planting. Statistical significance was evaluated at the 95 percent confidence level.

RESULTS

Survival

After three growing seasons, survival was above 90 percent for all treatment combinations. This high survival is of particular significance because of adverse weather conditions during the Summer of 1980, the growing season following planting. Record high temperatures and drought made this an exceptionally poor growing season, resulting in the widespread failure of recently established forest plantations.

There were no significant survival differences among the 5 species/seed source combinations. Green ash had the best survival (98%), while it was the same for sweetgum and sycamore (93 percent). Slightly lower survival in fertilized plots (93 percent) was not statistically different from that in unfertilized plots (95 percent). Fertilization at planting time followed by the adverse 1980 growing season would likely have resulted in much greater mortality from this treatment. Survival was 97 percent in disked plots, 94 percent for the controls, and 92 percent in mowed plots. This statistically significant survival advantage in the disked plots was probably related to improved water availability as seedlings became established during the 1980 drought.

Height Growth

Since seed source did not significantly influence height growth within a species, height measurements for sweetgum and sycamore from the two sources were combined.

Sycamore was the fastest growing of the species tested with a mean height of 9.0 feet after three growing seasons. This was significantly taller than either green ash (6.1 feet) or sweetgum (5.4 feet), between which growth differences were not significant.

The height growth of all three species was significantly increased by fertilization (Table 1). The greatest response was in green ash where fertilized trees were 25 percent taller than those not fertilized. Fertilizers stimulated sycamore and sweetgum growth by 19 percent and 16 percent, respectively. Even with fertilization the mean heights of green ash (6.7 feet) and sweetgum (5.9 feet) were considerably less than that of unfertilized sycamore (8.2 feet).

For all three species disking significantly stimulated growth over the other sub-plot treatments (Table 2). Response was greatest for sycamore (52 percent) followed by green ash (50 percent) and sweetgum (26 percent). Mowing did not significantly influence height growth for any of the three species tested.

Figure 1 provides a comparison of the response of the three species to the six combinations of cultural treatments tested. In general,

Table 1.--Mean heights of 3-year-old sweetgum, green ash, and sycamore for fertilized and control plots.

Species	Fertilized (feet)	Control (feet)	Difference (feet)	(%)
Sycamore	9.7	8.2	1.5	(19)
Green Ash	6.7	5.4	1.3	(25)
Sweetgum	7.0	6.0	1.0	(16)

Table 2.--Mean heights of 3-year-old sweetgum, green ash, and sycamore in mowed, disked, and control plots.

Species	Control (feet)	Mowed (*) (feet)	Disked (*) (feet)
Sweetgum	5.0	4.7 (-6)	6.3 (26)
Green Ash	5.2	5.2 (0)	7.8 (50)
Sycamore	7.7	7.5 (-2)	11.7 (52)

*Percent change in height as compared to control plot means.

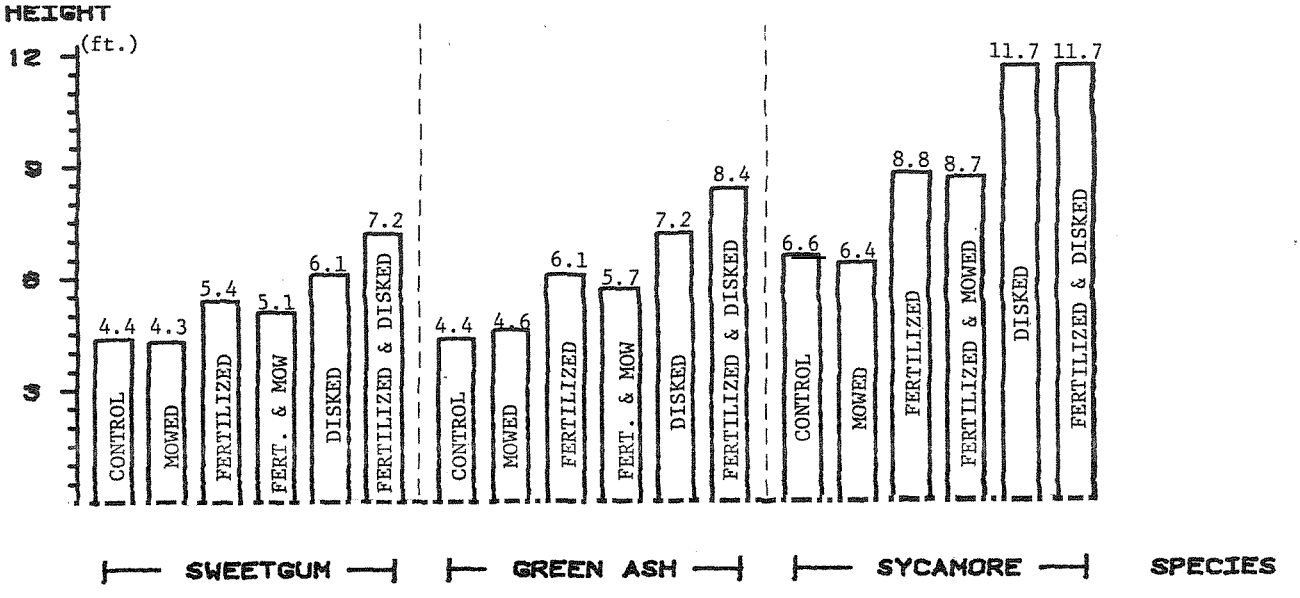

Fig. 1. Mean height of 3-year-old sweetgum, green ash, and sycamore after selected combinations of fertilization, disking, and mowing.

arrangement is according to increasing response, clearly indicating that mowing had little or no effect when applied alone or in combination with fertilization. Applied alone, both fertilization and disking significantly increased height growth for all three species. There was, however, no significant growth advantage from combining disking and fertilization, especially for sycamore.

DISCUSSION

Since after 3 growing seasons, survival rates for green ash, sweetgum, and sycamore were high for all treatments tested, all would provide fully stocked stands for the bottomlands of West Tennessee.

Disking appears to be the most effective cultural treatment for increasing the early growth rate of all species. Although disking is more expensive than either mowing or fertilization, it can essentially double height growth after three seasons for selected species (e.g. sycamore). For fertilized and/or disked sycamore, crown closure will be essentially completed by the end of the fourth growing season. This will eliminate the need for additional treatments to control competing vegetation.

Fertilization also stimulated height growth for all three species. Although disking produced taller trees, the high cost of the repeated on-site activity required for its effective application may make fertilization more economically feasible. There does not appear to be any significant growth advantage from applying both treatments.

Mowing did not significantly increase either survival or height growth for any of the species tested. It did change the composition of competing vegetation from broad leaf weeds to fast growing grasses. This probably increased competition for water and nutrients such that decreased competition for sunlight did not produce the growth gains anticipated. For the conditions tested in this study, mowing is not a recommended practice.

RECOMMENDATIONS

The results of this study suggest that three management intensities can be practically considered for establishing hardwoods on abandoned agricultural lands in West Tennessee. Simply planting to one of the three species tested would establish a stand of desirable hardwoods that should develop into a forest of superior composition and stocking. This would not occur if natural regeneration were relied upon for stand establishment.

A higher level of management would be to fertilize plantations at the beginning of the second growing season. This should result in a significant improvement in height growth for the three species tested, especially for green ash. This combination requires two treatment operations but would likely result in further gains over planting alone in that stand closure would occur earlier. This would reduce the time period over which there is intensive competition from herbaceous weeds.

A further gain can be realized by disking four or five times during the growing season for the first three seasons following planting. While disking appears to eliminate the need for a fertilizer treatment, it does require repeated visits to the plantation for several years, after which stand closure should be sufficient to eliminate the need for further treatment.

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